

What is claimed is:

1. Giant magnetostrictive material, comprising:

a mother alloy consisting essentially of a rare earth element and a transition metal element; and

5 nitrogen contained in the mother alloy;

wherein the nitrogen is interstitially introduced in the mother alloy, a content of a nitrogen compound (nitride) in the mother alloy, as a ratio of a content of nitrogen contained in the nitrogen compound to a total nitrogen
10 content in the mother alloy, being 0.05 or less by mass ratio.

2. The giant magnetostrictive material as set forth in claim 1:

wherein the nitrogen is contained in the mother alloy in the range from 0.01 to 2.5 % by mass.

15 3. The giant magnetostrictive material as set forth in claim 1:

wherein dispersion of the content of nitrogen introduced interstitially in the mother alloy is, with respect to an average value, within ± 30 %.

20 4. The giant magnetostrictive material as set forth in claim 1:

wherein a lattice constant of a grain of the mother alloy therein the nitrogen is introduced is increased by 0.1 % or more in comparison with that before introduction of
25 the nitrogen.

5. The giant magnetostrictive material as set forth in claim 1:

wherein the giant magnetostrictive material comprises

unidirectionally solidified material, single crystal material, melt quench material or sintered material.

6. The giant magnetostrictive material as set forth in claim 1:

5 wherein the giant magnetostrictive material comprises cubic cast material.

7. The giant magnetostrictive material as set forth in claim 1:

10 wherein the giant magnetostrictive material comprises an alloy thin film due to a film deposition process.

8. The giant magnetostrictive material as set forth in claim 5:

15 wherein, in 80 % or more by volume of grains in the alloy, a crystallographic direction in a direction of an applied magnetic field is oriented within ± 45 degrees from a crystallographic direction $\{1,1,1\}$ or $\{1,1,0\}$.

9. The giant magnetostrictive material as set forth in claim 1:

20 wherein the mother alloy comprises a composition essentially expressed by

a general formula: $R(T_x M_{1-x})_z$

(in the formula, R denotes at least one kind of element selected from rare earth elements including Y, T denotes at least one kind of element selected from Fe, Co and Ni, M denotes at least one kind of element selected from transition elements other than the T elements, and x and Z are numbers satisfying $0.5 \leq x \leq 1$, $1.4 \leq z \leq 2.5$).

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10. The giant magnetostrictive material as set forth

in claim 1:

wherein an oxygen content of the mother alloy is 20000 ppm or less.

11. The giant magnetostrictive material as set forth
5 in claim 1:

wherein a total content of fluorine and chlorine in the mother ally is 200 ppm or less.

12. The giant magnetostrictive material as set forth
in claim 1:

10 wherein the mother alloy comprises at least one kind selected from hydrogen, boron, carbon, phosphorus and silicon in the range from 0.0001 to 3 % by mass.

13. The giant magnetostrictive material as set forth
in claim 1:

15 wherein the giant magnetostrictive material has magnetostriction of 200 ppm or more.

14. Giant magnetostrictive material, comprising:
melt quench flakes that comprise an alloy consisting essentially of a rare earth element and a transition metal
20 element, and contain columnar structure extending in a thickness direction as a main crystal structure;

wherein the melt quench flakes are integrated stacked in a thickness direction.

15. The giant magnetostrictive material as set forth
25 in claim 14:

wherein the melt quench flakes contain the columnar structure grains by 70 % or more by volume ratio.

16. The giant magnetostrictive material as set forth

in claim 14:

wherein, in the columnar structure of the melt quench flakes, a crystallographic direction in the thickness direction is approximate orientation in {1,1,1} or {1,1,0}.

5 17. The giant magnetostrictive material as set forth in claim 16:

wherein, in an X-ray diffraction pattern of the melt quench flakes, a ratio of a peak intensity of a plane of crystallographic orientation of the columnar structure to
10 that of a reference peak is 1.5 times or more than random orientation.

18. The giant magnetostrictive material as set forth in claim 14:

wherein the melt quench flakes have an average
15 thickness in the range from 10 to 1000 μm .

19. The giant magnetostrictive material as set forth in claim 18:

wherein dispersion of the thickness of the melt quench flakes is within $\pm 20\%$ of the average thickness.

20 20. The giant magnetostrictive material as set forth in claim 14:

wherein the alloy comprises a composition essentially expressed by

a general formula: $R(T_x M_{1-x})_z$

25 (in the formula, R denotes at least one kind of element selected from rare earth elements including Y, T denotes at least one kind of element selected from Fe, Co and Ni, M denotes at least one kind of element selected from transition

elements other than the T elements, and x and Z are numbers satisfying $0.5 \leq X \leq 1$, $1.4 \leq Z \leq 2.5$).

21. The giant magnetostrictive material as set forth in claim 14:

5 wherein the alloy comprises nitrogen in the range from 0.01 to 2.5 % by mass, the nitrogen being interstitially introduced in the alloy.

22. The giant magnetostrictive material as set forth in claim 21:

10 wherein a content of a nitrogen compound in the alloy, as a ratio of a content of nitrogen contained in the nitrogen compound to a total nitrogen in the alloy, is 0.05 or less by mass ratio.

23. A method for manufacturing giant magnetostrictive material, comprising the steps of:

15 heat treating a mother alloy consisting essentially of a rare earth element and a transition metal element in an atmosphere of a vacuum or an inert gas; and

20 introducing nitrogen interstitially between crystal lattice of the mother alloy in a temperature range of 600°C or less.

24. The method for manufacturing giant magnetostrictive material as set forth in claim 23:

25 wherein the nitrogen introducing step is controlled so that the nitrogen is contained in the mother alloy in the range from 0.01 to 2.5 % by mass, and a content of nitrogen compound in the mother alloy, by a mass ratio of a content of nitrogen contained in the nitrogen compound to a total

nitrogen content in the mother alloy, is 0.05 or less.

25. The method for manufacturing giant magnetostrictive material as set forth in claim 23:

5 wherein the nitrogen introducing step comprises a step of heat treating the mother alloy in an atmosphere containing nitrogen at a temperature in the range from 200 to 600°C.

26. The method for manufacturing giant magnetostrictive material as set forth in claim 23:

10 wherein the nitrogen introducing step comprises a step of mechanical alloying the mother alloy in an atmosphere containing nitrogen.

27. A method for manufacturing giant magnetostrictive material, comprising the steps of:

15 quenching alloy melt consisting essentially of a rare earth element and a transition metal element to prepare melt quench flakes containing columnar structure extending in a thickness direction as a main crystal structure; and

20 stacking the melt quench flakes in a direction of thickness to integrate a stacked body of the melt quench flakes.

28. The method for manufacturing giant magnetostrictive material as set forth in claim 27:

25 wherein the integrating step comprises a step of stacking the melt quench flakes for a crystallographic direction of a direction of thickness of the columnar structure to orient.

29. The method for manufacturing giant magnetostrictive material as set forth in claim 27:

wherein the integrating step comprises a step of hot pressing or spark plasma sintering the stacked body of the melt quench flakes.

30. The method for manufacturing giant
5 magnetostrictive material as set forth in claim 29:

wherein to the melt quench flakes, as a sintered additive, fine powder of the same constituent with the melt quench flakes or fine powder that fuses with the melt quench flakes to form a target constituent is added in the range of
10 30 % or less by mass to the melt quench flakes.

31. The method for manufacturing giant magnetostrictive material as set forth in claim 27:

wherein the integrating step comprises a step of integrating the stacked body of the melt quench flakes by the
15 use of a resinous binder.

32. The method for manufacturing giant magnetostrictive material as set forth in claim 27:

wherein 70 % or more by mass of the melt quench flakes have a dimension of (minor axis of flake) $>3\times$ (average
20 thickness of flake) and (major axis of flake)/(minor axis of flake) = 1 to 20.

33. A magnetostrictive actuator, comprising:
giant magnetostrictive material set forth in claim 1.

34. A magnetostrictive actuator, comprising:
25 giant magnetostrictive material set forth in claim 14.

35. A magnetostrictive sensor, comprising:
giant magnetostrictive material set forth in claim 1.

36. A magnetostrictive sensor, comprising:

giant magnetostrictive material set forth in claim 14.